

PROCEDURE 56

Arterial Catheter Insertion (Assist), Care, and Removal

P U R P O S E: Arterial pressure lines are used to continuously monitor blood pressure, to titrate vasoactive agents, and to obtain serial blood gases or other laboratory specimens in critically ill patients.

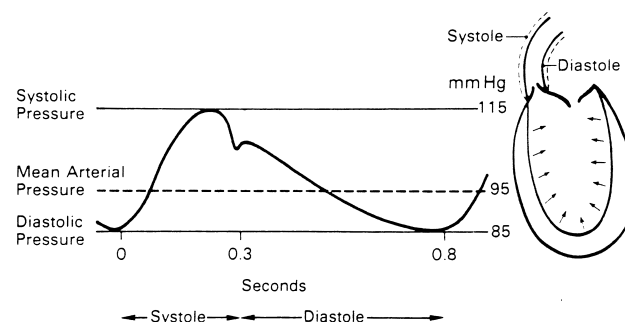
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PREREQUISITE NURSING KNOWLEDGE

- Knowledge of the anatomy and physiology of the vasculature and adjacent structures is important.
- Principles of hemodynamic monitoring should be understood.
- Conditions that warrant the use of arterial pressure monitoring include patients with the following:
 - ❖ Acute hypotension or hypertension (hypertensive crisis)
 - ❖ Hemodynamic instability or circulatory collapse
 - ❖ Cardiac arrest
 - ❖ Hemorrhage
 - ❖ Shock from any cause
 - ❖ Continuous infusion of vasoactive medications
 - ❖ Frequent arterial blood gas measurements
 - ❖ Nonpulsatile blood flow (ie, those using ventricular assist devices or receiving extracorporeal membrane oxygenation)
 - ❖ Intra-aortic balloon pump therapy
 - ❖ Neurologic injury
 - ❖ Coronary interventional procedures
 - ❖ Major surgical procedures
 - ❖ Multiple trauma
 - ❖ Respiratory failure
 - ❖ Sepsis
 - ❖ Obstetric emergencies
- Arterial pressure represents the forcible ejection of blood from the left ventricle into the aorta and out into the arterial system. During ventricular systole, blood is ejected into the aorta, generating a pressure wave. Because of the intermittent pumping action of the heart, this arterial pressure wave is generated in a pulsatile manner (Fig. 56–1). The ascending limb of the aortic pressure wave (anacrotic limb) represents an increase in pressure because of left ventricular ejection. The peak of this ejection is the peak systolic pressure, which is normally 100 to 140 mm Hg in adults. After reaching this peak, the ventricular pressure declines to a level below aortic pressure, and the aortic valve closes, marking the end of

ventricular systole. The closure of the aortic valve produces a small rebound wave that creates a notch known as the *dicrotic notch*. The descending limb of the curve (diastolic downslope) represents diastole and is characterized by a long declining pressure wave, during which the aortic wall recoils and propels blood into the arterial network. The diastolic pressure is measured as the lowest point of the diastolic downslope and is normally 60 to 80 mm Hg.

- The difference between the systolic and diastolic pressures is called the *pulse pressure*, with a normal value of 40 mm Hg.
- Arterial pressure is determined by the relationship between blood flow through the vessels (*cardiac output*) and the resistance of the vessel walls (*systemic vascular resistance*). The arterial pressure is therefore affected by



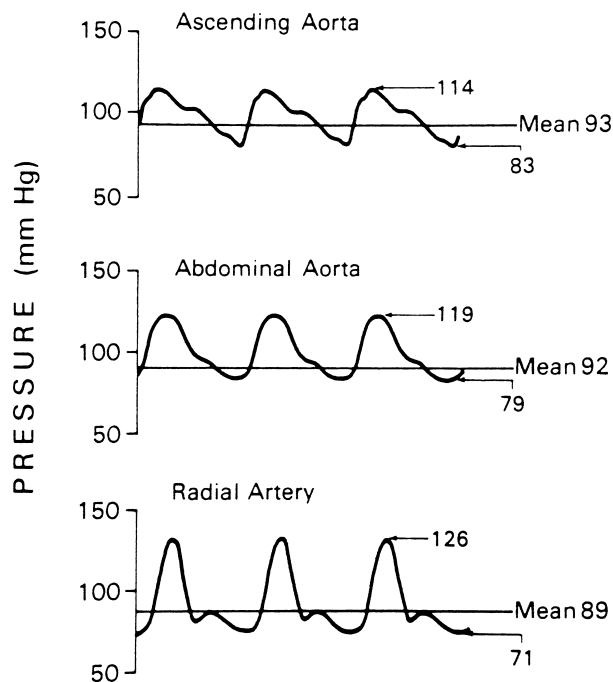
■ ● **FIGURE 56–1.** The generation of a pulsatile waveform. This is an aortic pressure curve. During systole, the ejected volume distends the aorta and aortic pressure rises. The peak pressure is known as the *aortic systolic pressure*. After the peak ejection, the ventricular pressure falls, and when it drops below the aortic pressure, the aortic valve closes, which is marked by the *dicrotic notch*, the end of the systole. During diastole, the pressure continues to decline and the aortic wall recoils, pushing the blood toward the periphery. The trough of the pressure wave is the *diastolic pressure*. The difference between systolic and diastolic pressure is the *pulse pressure*. (From Smith JJ, Kampine JP. *Circulatory Physiology*. Baltimore, Md: Williams & Wilkins; 1980:55.)

any factors that change either cardiac output or systemic vascular resistance.

- The average arterial pressure during a cardiac cycle is called the *mean arterial pressure* (MAP). It is not the average of the systolic plus the diastolic pressures because during the cardiac cycle, the pressure remains closer to diastole for a longer period than to systole (at normal heart rates). The MAP is calculated automatically by most patient monitoring systems; however, it can be calculated roughly by using the following formula:

$$\text{MAP} = \frac{(\text{systolic pressure}) + (\text{diastolic pressure} \times 2)}{3}$$

- MAP represents the driving force (perfusion pressure) for blood flow through the cardiovascular system. MAP is at its highest point in the aorta. As blood travels through the circulatory system, systolic pressure increases and diastolic pressure decreases, with an overall decline in the MAP (Fig. 56–2).
- The location of the arterial catheter depends on the patient's age, the condition of the arterial vessels, and the presence of other catheters (ie, the presence of a dialysis shunt is a contraindication for placing an arterial catheter in the same extremity). Once inserted, the arterial catheter causes little or no discomfort to the patient and allows continuous blood pressure assessment and intermittent blood sampling. If intra-aortic balloon pump therapy is required, arterial pressure may be directly monitored from the tip of the balloon in the aorta.



■ ● **FIGURE 56–2.** Arterial pressure from different sites in arterial tree. The arterial pressure waveform will vary in configuration depending on the location of the catheter. With transmission of the pressure wave into the distal aorta and large arteries, the systolic pressure increases and the diastolic pressure decreases; with a resulting heightening of the pulse, pressure declines steadily. (From Smith JJ, Kampine JP. *Circulatory Physiology*. Baltimore, Md: Williams & Wilkins; 1980: 57.)

- When arterial pulse waveforms are recorded from sites distal to the aorta, changes in the arterial waveforms often occur. The anacrotic limb becomes more peaked and narrowed, with increased amplitude; therefore, the systolic pressure in distal sites is higher than the systolic pressure recorded from a more central site (see Fig. 56–2). The diastolic downslope may demonstrate a secondary wave, and the dicrotic notch becomes less prominent from distal sites.
- There are several potential complications associated with arterial pressure monitoring. Infection at the insertion site can develop and cause sepsis. Clot formation in the catheter can lead to arterial embolization. The catheter can cause vessel perforation with extravasation of blood and flush solution into the tissues. Lastly, the distal extremity can develop circulatory or neurologic impairment.

EQUIPMENT

- 10% povidone-iodine solution
- Alcohol pads or swab sticks
- 1% lidocaine solution without epinephrine
- 10-mL syringe with an 18-G and a 22-G needle
- 3-mL syringe with a 25-G needle
- Chux
- Sterile towels
- 1- to 2-in (2.5- to 5-cm) over-the-needle catheter (14- 18-G for adults)
- Sterile 4 × 4 gauze pads
- Tape
- Hemodynamic monitoring system: pressure device, flush bag, pressurized tubing, transducer, monitor cable, and monitor (see Procedure 69)
- Nonsterile gloves, sterile gloves, and goggles
- Suture materials

Additional equipment to have available as needed includes the following:

- Arm board
- Transparent dressing
- Bath towel

PATIENT AND FAMILY EDUCATION

- Assess patient and family understanding of the reason for arterial line insertion, including how the arterial pressure is displayed on the bedside monitor. ► **Rationale:** Decreases patient and family anxiety.
- Explain the standard of care to the patient and family, including insertion procedure, alarms, dressings, potential need for immobility of affected extremity, and length of time catheter is expected to be in place. ► **Rationale:** Encourages patient and family to ask questions and voice concerns about the procedure.
- Explain the patient's expected participation during the procedure. ► **Rationale:** Encourages patient cooperation during insertion.
- Explain the importance of keeping the affected extremity immobile. ► **Rationale:** Encourages patient compliance to prevent catheter dislodgment and ensures more accurate waveform.
- Instruct the patient to report any warmth, redness, pain, or wet feeling at the insertion site at any time, including

after catheter removal. ➤➤**Rationale:** May indicate infection, bleeding, or disconnection of the tubing.

PATIENT ASSESSMENT AND PREPARATION

Patient Assessment

- Obtain medical history, including diabetes, hypertension, peripheral vascular disease, vascular grafts, arterial vasospasm, thrombosis, or embolism. Obtain history of prior coronary artery bypass graft surgery in which radial arteries were removed for use as conduits. ➤➤**Rationale:** Extremities with any of these problems should be avoided as sites for cannulation because of their potential for complications. Patients with diabetes mellitus or hypertension are at higher risk of arterial or venous insufficiency. Previously removed radial arteries are a contraindication for ulnar artery cannulation.
- Obtain specific neurovascular and peripheral vascular assessment of the extremity to be used for arterial cannulation, including assessment of color, temperature, presence and fullness of pulses, capillary refill, and motor and

sensory function (as compared with opposite extremity). **Note:** A modified Allen test is performed before cannulation of a radial or ulnar artery (see Fig. 72–3). ➤➤**Rationale:** Identifies any circulatory or neurologic impairment before cannulation to avoid potential complications.

Patient Preparation

- Ensure that the patient and family understand preprocedural teaching. Answer questions as they arise and reinforce information as needed. ➤➤**Rationale:** Evaluates and reinforces understanding of previously taught information.
- Ensure that informed consent was obtained. ➤➤**Rationale:** Protects rights of patient and makes competent decision possible for the patient; however, under emergency circumstances, time may not allow form to be signed.
- Place the patient's extremity in the appropriate position with adequate lighting of insertion site. ➤➤**Rationale:** Prepares site for cannulation and facilitates accurate insertion.

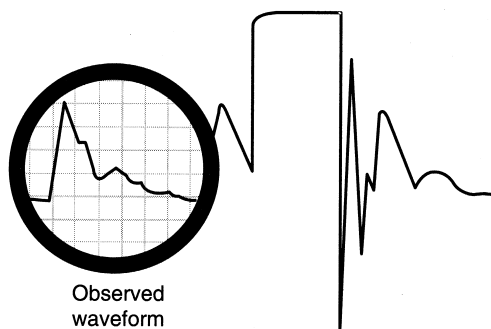
Procedure for Assisting with Insertion, Care and Removal of Arterial Pressure Lines

Steps	Rationale	Special Considerations
1. Wash hands.	Reduces transmission of microorganisms; standard precautions.	
2. If catheter is to be inserted in the radial or ulnar artery, perform a modified Allen's test (see Fig. 72–3). (Level II: Theory based, no research data to support recommendations; recommendations from expert consensus group may exist)	Ensures adequacy of collateral blood flow of upper extremity to be cannulated. ^{1–5}	

Procedure continued on page 371

When the fast flush of the continuous flush system is activated and quickly released, a sharp upstroke terminates in a flat line at the maximal indicator on the monitor and hard copy. This is then followed by an immediate rapid downstroke extending below baseline with just 1 or 2 oscillations within 0.12 seconds (minimal ringing) and a quick return to baseline. The patient's pressure waveform is also clearly defined with all components of the waveform, such as the dicrotic notch on an arterial waveform, clearly visible.

Square wave test configuration

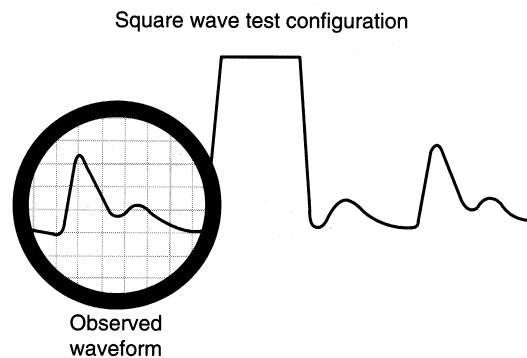


■ ● **FIGURE 56-3A.** Optimally damped system. Dynamic response test (square wave test) using the fast flush system normal response. (Fig. 56–3 from Darovic GO, Vanriper S, Vanriper J. Fluid-filled monitoring systems. In: Darovic GO. *Hemodynamic Monitoring*. 2nd ed. Philadelphia, Pa: WB Saunders; 1995:161–162.)

Intervention

There is no adjustment in the monitoring system required.

The upstroke of the square wave appears somewhat slurred, the waveform does not extend below the baseline after the fast flush and there is no ringing after the flush. The patient's waveform displays a falsely decreased systolic pressure and false high diastolic pressure as well as poorly defined components of the pressure tracing such as a diminished or absent dicrotic notch on arterial waveforms.



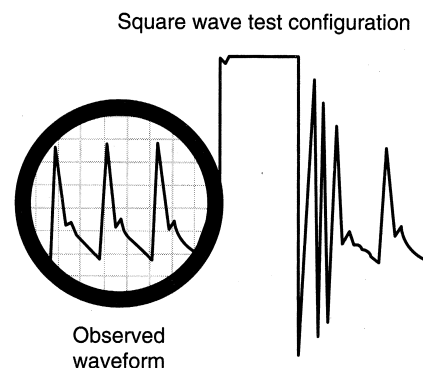
Intervention

To correct for the problem:

1. Check for the presence of blood clots, blood left in the catheter following blood sampling, or air bubbles at any point from the catheter tip to the transducer diaphragm and eliminate these as necessary.
2. Use low compliance (rigid), short (less than 3 to 4 feet) monitoring tubing.
3. Connect all line components securely.
4. Check for kinks in the line.

■ ● FIGURE 56-3B. Overdamped system. Dynamic response test (square wave test) using the fast flush system damped response.

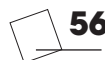
The waveform is characterized by numerous amplified oscillations above and below the baseline following the fast flush. The monitored pressure wave displays false high systolic pressures (overshoot), possibly false low diastolic pressures, and “ringing” artifacts on the waveform.



■ ● FIGURE 56-3C. Underdamped system. Dynamic response test (square wave test) using the fast flush system underdamped response.

Intervention

To correct the problem, remove all air bubbles (particularly pinpoint air bubbles) in the fluid system, use large-bore, shorter tubing, or use a damping device.

**Procedure****for Assisting with Insertion, Care, and Removal of Arterial Pressure Lines**
Continued

Steps	Rationale	Special Considerations
<p>3. When preparing flush bag, mix solution of heparinized saline if heparin use is not contraindicated. (<i>Level V: Clinical studies in more than one or two different patient populations and situations to support recommendations</i>)</p> <p><i>Note:</i> Do not use heparinized dextrose solutions. (<i>Level VI: Clinical studies in a variety of patient populations and situations to support recommendations</i>)</p>	<p>Catheters flushed with heparinized saline are more likely than those flushed with nonheparinized saline to remain patent up to 72 hours.^{6, 7} Use of heparin is contraindicated in patients with heparin-induced thrombocytopenia or heparin allergy.</p> <p>Dextrose supports the growth of microorganisms. These solutions have been associated with infection.^{8, 9}</p>	<p>Follow institutional protocol for amount of heparin per milliliter of flush solution, usually 1 to 4 U/mL. Other factors that promote patency of the arterial line besides heparinized saline include the following: male sex, longer catheters, larger vessels, and short-term use of the catheter.⁶</p>
<p>4. Use a closed tubing system if possible. (<i>Level IV: Limited clinical studies to support recommendations</i>)</p>	<p>May reduce the risk of nosocomial infection.^{9, 10}</p>	
<p>5. Consider using tubing with an in-line blood discard reservoir. (<i>Level IV: Limited clinical studies to support recommendations</i>)</p>	<p>May reduce the risk of nosocomial anemia.^{11, 12}</p>	
Assisting with Insertion		
<p>1. Wash hands, and don gloves and goggles.</p>	<p>Reduces transmission of microorganisms; standard precautions.</p>	
<p>2. Prepare hemodynamic monitoring system (see Procedure 69).</p>	<p>Prepares monitoring system.</p>	
<p>3. Immobilize site during catheter insertion.</p>	<p>Facilitates insertion; may prevent needle from lacerating vessel wall during insertion.</p>	<p>Sedation may be necessary if the patient is restless.</p>
<p>4. Assist with catheter insertion.</p>	<p>Allows for smooth, cooperative effort.</p>	
<p>5. Once catheter is positioned, connect tubing with Luer-Lok adapter to arterial catheter.</p>	<p>Provides secure attachment and allows signal to be transmitted to monitor via transducer.</p>	<p>Catheter must be held in place while connections are made.</p>
<p>6. Observe waveform and perform a dynamic response test (square wave test; Fig. 56–3).</p>	<p>Results indicate whether or not the system is damped.</p>	
<p>7. Assist with securing or suturing catheter in place.</p>	<p>Catheter is at risk of becoming dislodged until secured.</p>	
<p>8. Once the catheter is secured in place, apply a sterile, occlusive dressing.</p>	<p>Provides sterile environment; reduces infection.</p>	<p>Refer to institutional policy. Studies of the efficacy of using antimicrobial ointments at the catheter site to prevent infection are contradictory. The Centers for Disease Control and Prevention do not recommend the routine application of topical antimicrobial ointment to the insertion site of peripheral venous catheters but do not make a specific recommendation for peripheral arterial catheters.⁹ Additionally, studies reveal controversy about which dressing to use over arterial insertion sites to prevent infection—transparent or gauze dressings. More research is needed, specifically with respect to peripheral arterial catheters.</p>

Procedure continued on following page

Procedure for Assisting with Insertion, Care and Removal of Arterial Pressure Lines *Continued*

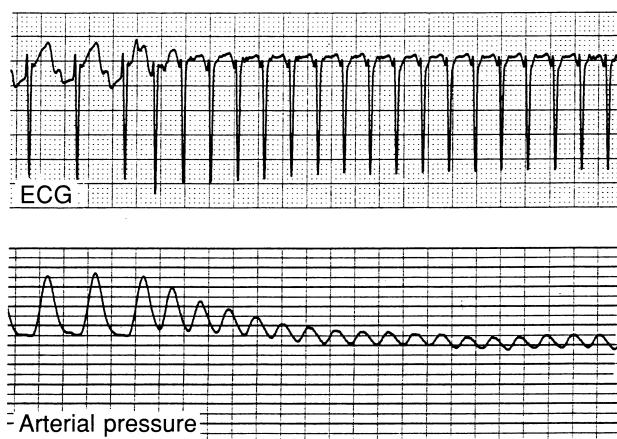
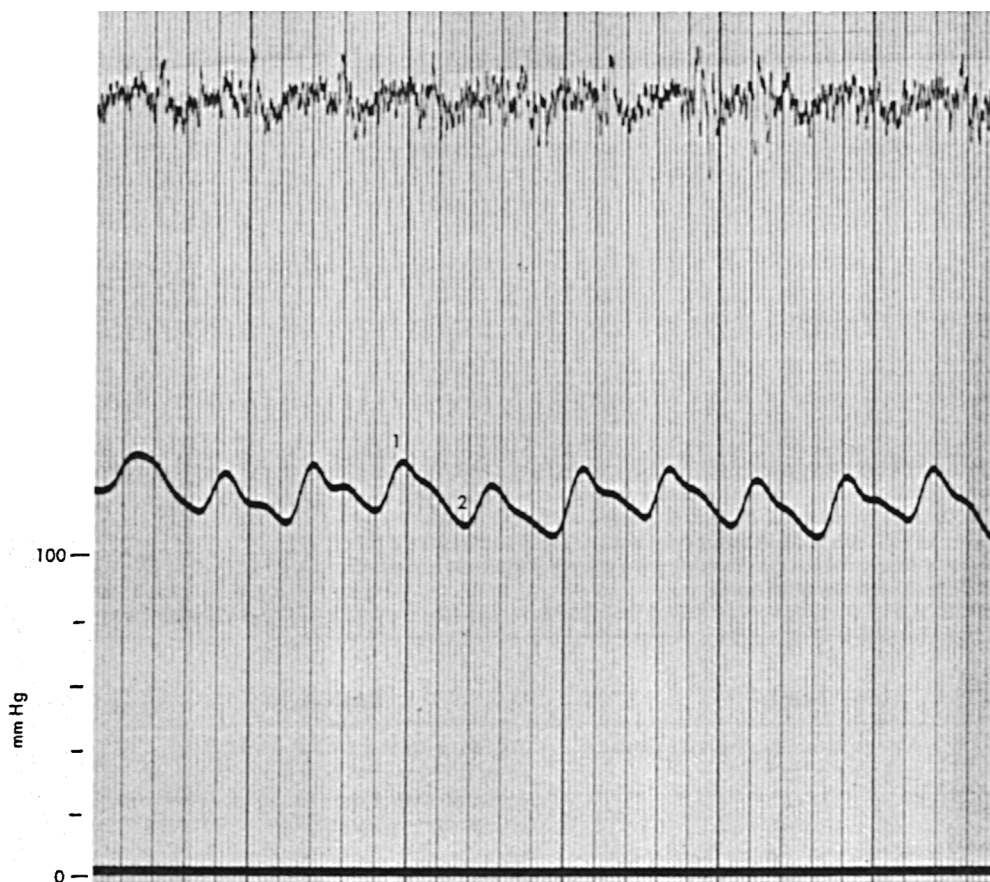
Steps	Rationale	Special Considerations
9. Apply armboard if necessary.	Ensures correct position of extremity for optimal waveform.	
10. Level and zero the transducer (see Procedure 69).	Prepares monitoring system.	
11. Set alarm parameters according to patient's current blood pressure.	Alarms should always be on to detect pulseless electrical activity, hypotension, hypertension, accidental disconnection, accidental removal of catheter, or overdamping of waveform.	
12. Discard used supplies and wash hands.	Reduces transmission of microorganisms; standard precautions.	
13. Run a waveform strip and record baseline pressures.	Obtains baseline data.	Never rely on digital values because the values are averaged calculations.

Procedure for Troubleshooting an Overdamped Waveform

Steps	Rationale	Special Considerations
1. Identify the overdamped waveform (Fig. 56-4).	Identifies problem.	
2. Check the patient.	A sudden hypotensive episode can look like an overdamped waveform (Fig. 56-5).	
3. Check that the pressure bag is inflated to 300 mm Hg.	Underinflation or overinflation can distort the waveform.	
4. Perform a dynamic response test if the arterial waveform seems to be overdamped (see Fig. 56-3).	Overdamping should be assessed immediately to ensure waveform accuracy and to prevent clotting of the catheter.	
5. If the waveform is overdamped, follow these steps:		
A. Check the arterial line insertion site for catheter positioning.	In the radial site, wrist movement—or in the femoral site, leg flexion—can cause catheter kinking or dislodgment and result in an overdamped waveform.	
B. Check the system for air bubbles and eliminate them if they are found.	Air bubbles can be a cause of an overdamped system; air bubbles can also cause emboli.	
C. Check the tubing system for leaks or disconnections and correct the problem if it is found.	Ensure that all connections are tight.	

Procedure continued on page 374

■ ● **FIGURE 56-4.** Overdamped arterial waveform (1 = systole; 2 = diastole). (From Daily EK, Schroeder JS. *Hemodynamic Waveforms*. St. Louis, Mo: Mosby-Year Book; 1990: 110.)



■ ● **FIGURE 56-5.** Patient developed a supraventricular tachycardia (SVT) with a fall in arterial pressure. Note how the arterial line appears overdamped but is in fact reflecting a severe hypotensive episode associated with the tachycardia.

Procedure for Troubleshooting an Overdamped Waveform *Continued*

Steps	Rationale	Special Considerations
D. Attempt to aspirate and flush catheter as follows: <i>Note:</i> A catheter with an overdamped waveform should always be aspirated before flushing.	Assists with the withdrawal of air in tubing or clots that may be at catheter tip.	
<ul style="list-style-type: none"> ○ Wash hands, and don gloves. ○ Attach a 10-mL syringe to the blood sampling port of the stopcock closest to the patient. ○ Turn stopcock off to flush bag. ○ Gently attempt to aspirate; if resistance is felt, reposition the extremity and reattempt aspiration. If resistance is still felt, stop and notify the physician or advanced practice nurse. ○ If blood is aspirated, remove 3 mL, turn stopcock off to patient, and discard the 3-mL sample. ○ Hold a 4 × 4 gauze pad over the blood sampling port of stopcock. Activate fast-flush device to clear stopcock of blood. ○ Turn stopcock off to blood sampling port and replace it with a sterile occlusive cap. ○ Use fast-flush device to clear line of blood. 	<p>Using the fast-flush device or flushing with a syringe first may force a clot at the catheter tip into the arterial circulation.</p> <p>Reduces transmission of microorganisms; standard precautions.</p> <p>A 10-mL syringe generates less pressure.</p> <p>Opens the system from the patient to the syringe.</p> <p>Allows check on catheter patency.</p> <p>Normally, blood should be aspirated into the syringe without difficulty.</p>	
6. Discard used supplies, and wash hands.	Removes any clotted material within the catheter.	All blood wastes should be disposed of following standard precautions.
	Removes blood residue from stopcock, where it could be a reservoir for bacterial growth.	
	Maintains sterility and closed system.	
	Prevents arterial line from clotting.	
	Reduces transmission of microorganisms; standard precautions.	

Procedure for Troubleshooting an Underdamped Waveform

Steps	Rationale	Special Considerations
1. Identify the underdamped waveform (see Fig. 56–3C).	Identifies problem.	
2. Wash hands.	Reduces transmission of microorganisms; standard precautions.	
3. Check the system for air bubbles and eliminate them if they are found.	Air bubbles can contribute to underdamping; air bubbles can also cause emboli.	
4. Check the length of the pressurized tubing system.	Ensure that the tubing length is minimized.	
5. Consider use of a damping device.	These devices mechanically alter damping.	Follow institution standard regarding use of damping devices.
6. Wash hands.	Reduces transmission of microorganisms; standard precautions.	



Procedure for Arterial Line Dressing Change

Steps	Rationale	Special Considerations
1. Frequency of dressing change is determined by type of dressing material used and unit policy.	Prevents infection at insertion site.	The Centers for Disease Control and Prevention recommend replacing the dressing when the catheter is replaced (at least every 96 hours); when the dressing becomes damp, loosened, or soiled; or if inspection of the site is required. ⁹
A. Wash hands, and don gloves.	Reduces transmission of microorganisms; standard precautions.	
B. Gently remove old dressings, being careful not to place tension on arterial catheter.	Prevents inadvertent dislodgment of catheter.	If excessive tape is used, use extreme care to secure the catheter while removing the tape. A second health care provider may be needed to assist with dressing removal to prevent accidental dislodgment or removal of the arterial catheter.
C. Observe for signs of infection.	Early detection may prevent bacteremia.	An infected catheter is removed, and the tip is sent for culture.
D. Cleanse insertion site with 10% povidone-iodine solution and allow to dry.	Iodine solutions need to air dry for maximum effectiveness and to help prevent the growth of bacteria at the insertion site.	
E. Replace dressing using aseptic technique.	Decreases risk of infection.	
F. Discard used supplies and wash hands.	Reduces transmission of microorganisms; standard precautions.	

Procedure for Removal of Arterial Catheter

Steps	Rationale	Special Considerations
1. Wash hands, and don gloves and goggles.	Reduces transmission of microorganisms; standard precautions.	Refer to institutional policy regarding removal of arterial catheters from sites other than radial or ulnar arteries.
2. Turn off continuous infusion, and turn off monitoring alarms.	Prevents flush solution from leaking and prevents false alarms.	
3. Attach syringe to blood sampling port, turn stopcock off to flush bag, and draw blood back through the tubing.	Ensures there is no clot in the catheter.	If unable to draw blood back, notify physician or advanced practice nurse.
4. Apply pressure distal to the insertion site.	Prepares for removal.	
5. Pull out catheter using a sterile 4 × 4 gauze pad to cover site as catheter is pulled out.	Prevents splashing of blood.	
6. Immediately apply firm pressure with a sterile 4 × 4 gauze pad proximal to the insertion site.	Prevents bleeding.	
7. Continue to apply pressure for a minimum of 5 minutes for radial or ulnar artery site.	Achieves hemostasis.	Longer periods of direct pressure may be needed to achieve hemostasis in patients receiving systemic heparin or thrombolytics or those with catheters in larger arteries (ie, in the femoral artery). With large catheters used for angiography or intra-aortic balloon pump therapy, direct pressure may be held for 30 to 60 minutes followed by bedrest for 6 to 8 hours after catheter removal.
8. Apply a pressure dressing to the insertion site.	A pressure dressing will help prevent rebleeding.	Dressing should not encircle extremity to prevent ischemia of extremity.
9. Discard supplies and wash hands.	Reduces transmission of microorganisms; standard precautions.	

Expected Outcomes	Unexpected Outcomes
<ul style="list-style-type: none"> • Minimal discomfort from arterial catheter • Maintenance of baseline hemoglobin and hematocrit levels • Adequate circulation to the involved extremity • Adequate sensory and motor function of the extremity • Remaining euvolemic 	<ul style="list-style-type: none"> • Pain or discomfort from arterial catheter insertion site • Redness, warmth, edema, or drainage at or from the insertion site • Elevated temperature or elevated white blood cell count • Decreased hemoglobin and hematocrit • Impaired peripheral tissue perfusion (ie, edema, coolness, pain, paleness, or slow capillary refill of fingers or toes of cannulated extremity) • Impaired sensory or motor function of the extremity • Catheter disconnection with significant blood loss • Fluid volume overload

Patient Monitoring and Care

Patient Monitoring and Care	Rationale	Reportable Conditions
<ol style="list-style-type: none"> 1. Monitor neurovascular and peripheral vascular assessments of the cannulated extremity immediately after catheter insertion and every 4 hours, or more often if warranted, or according to unit policy. 	<p>Validates adequate peripheral circulation and neurovascular integrity. Changes in pulses, color, temperature, or capillary refill may indicate ischemia, arterial spasm, or neurovascular compromise.</p>	<p><i>These conditions should be reported if they persist despite nursing interventions.</i></p> <ul style="list-style-type: none"> • Diminished or absent pulses • Pale, mottled, or cyanotic appearance of extremity • Extremity that is cool or cold to the touch • Capillary refill time of more than 2 seconds • Diminished or absent sensation • Diminished or absent motor function • Pallor or cyanosis
<ol style="list-style-type: none"> 2. Check arterial line flush system every 1 to 4 hours to ensure the following: <ul style="list-style-type: none"> ○ Pressure bag is inflated to 300 mm Hg. ○ Fluid is present in flush bag. ○ Flush system is delivering 1 to 3 mL/h. 	<p>Ensures accuracy of pressure waveform and functioning of system.</p> <p>Necessary for proper function of flush device and to prevent backflow of blood into catheter and tubing.</p> <p>Catheter will clot off if fluid is not continuously infusing.</p> <p>Maintains catheter patency and prevents fluid overload.</p>	
<ol style="list-style-type: none"> 3. Monitor for overdamped or underdamped waveform. <ul style="list-style-type: none"> ○ An overdamped waveform is characterized by a flattened waveform, a diminished or absent dicrotic notch, or a waveform that does not fall to baseline (see Fig. 56–4). ○ An underdamped waveform is characterized by catheter fling. 	<p>An optimally damped system provides an adequate waveform with appropriate blood pressure readings.</p> <p>With an overdamped waveform, systolic pressure may be read inaccurately low. Common causes of overdamped waveform include the following: air bubbles in system, use of compliant tubing, loose connections in system, too many stopcocks in system, cracked stopcock, arterial cannula occlusion, catheter tip against arterial wall, and insufficient pressure in pressure bag.</p> <p>With an underdamped waveform, systolic pressures may be read inaccurately high. Common causes of an underdamped waveform include the following: excessive tubing length, movement of the catheter in the artery, patient movement, and air bubbles in the system.</p>	<ul style="list-style-type: none"> • Overdamped or underdamped waveform that cannot be corrected with troubleshooting procedures

**Patient Monitoring and Care** *Continued*

Patient Monitoring and Care	Rationale	Reportable Conditions
4. Perform a dynamic response test every 8 to 12 hours or when the system is opened to air or when the accuracy of readings is in question (see Fig. 56–3).	An optimally damped system provides an accurate waveform.	<ul style="list-style-type: none"> Overdamped or underdamped waveform that cannot be corrected with troubleshooting procedures
5. Zero the transducer during initial setup and before insertion, if the transducer and the monitoring cable are disconnected, if the monitoring cable and the monitor are disconnected, and when the values obtained do not fit the clinical picture. Follow manufacturer's recommendations for both disposable and reusable systems.	Ensures accuracy of the hemodynamic monitoring system; minimizes risk of contamination of the system.	
6. Observe insertion site for signs of infection.	Infected catheters must be removed as soon as possible to prevent bacteremia. The tip should be sent for culture.	<ul style="list-style-type: none"> Purulent drainage Tenderness or pain at insertion site Elevated temperature Elevated white blood cells
7. Change the catheter site, pressure tubing, flush bag, and transducer every 96 hours or with each change of the catheter if it is changed more frequently. The flush bag may need to be changed more frequently if it is empty of solution. (Level IV: Limited clinical studies to support recommendations)	Changing the flush bag and system more often than every 96 hours may cause contamination and increase the risk of infection. ^{9, 13, 14}	
8. Run an arterial pressure strip and obtain measurement of the arterial pressures during end-expiration.	Eliminates the effect of the respiratory cycle on arterial pressure.	
9. Obtain an arterial waveform strip to place on the patient's chart at the start of each shift or whenever there is a change in the waveform.	The printed waveform allows assessment of the adequacy of the waveform, damping, or respiratory variation.	
10. Monitor hemoglobin or hematocrit daily or whenever a significant amount of blood is lost through the catheter (eg, through accidental disconnection).	Allows assessment of nosocomial anemia.	<ul style="list-style-type: none"> Changes in hemoglobin and hematocrit

Documentation

Documentation should include the following:

- Patient and family education
- Peripheral vascular and neurovascular assessment before and after the procedure
- Date and time of insertion with size of catheter placed
- Condition of insertion site
- Patient response to insertion procedure
- Type of flush solution used
- Intake of flush solution (eg, 3 mL/h)
- Initial insertion recorded and waveform labeled with the date, time, and systolic and diastolic pressures
- Unexpected outcomes
- Additional nursing interventions

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